LAWRENCE LIVERMORE LABORATORY

March 27, 1975

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Washington, D.C. 20545

Dear Rudy:

With the increasing pressures for greater domestic energy production, ERDA is proposing and many utility executives are urging that this country's coal reserves be rapidly developed to serve as the backbone of United States' energy resources for at least the next hundred years. In the atmospheric sciences, these plans have prompted formation of a research program to investigate the potential sulfur/sulfate concentrations which may result. But at this crucial juncture in energy planning, there seems to have been no critical assessment similar to the CIAP weighing the relative merits of fossil fuel usage and, for example, nuclear or solar energy generation in which the implications and consequences of continuing reliance on combustion of fossil fuels and the resulting increase in atmospheric carbon dioxide concentrations have been carefully considered. Rather, an implicit assumption has apparently been made that increasing atmospheric carbon dioxide is of no significance; a decision made without assessing the current indications that small changes can cause large effects (e.g., Grobecker, Coroniti, and Cannon, 1974).

Carbon dioxide is the one atmospheric constituent for which there is a very good evidence that it has been increasing from about 290 ppm in the mid 1800's to more then 325 ppm at present (see, for example, Callendar, 1958; Revelle, 1965; SCEP, 1970; SMIC, 1971). And based on extensive studies of the carbon cycle, it seems quite clear that the approximately 12% increase in atmospheric carbon dioxide concentrations is well within the emission estimates from anthropogenic sources. In fact present estimates of CO_2 emissions require that about half of the emissions be taken up by the oceanic and/or other carbon reservoirs in order to limit the rate of increase in concentrations to the rate which is observed.

A number of investigators (e.g., Machta, 1972; Dugas, 1968; SCEP, 1970; Fairhall, 1973; Cramer and Myers, 1972) have attempted to model the carbon cycle treating the various carbon reservoirs (namely, the atmosphere, biosphere, humus, mixed ocean layer, and deep ocean) in differing detail. And the entire carbon cycle has recently been reviewed in a biology related

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symposium (Woodwell and Pecan, 1973). While the projections for future atmospheric concentrations differ, they are unanimous in seeing a continuing increase in atmospheric carbon dioxide concentrations if emissions continue at reasonably projected rates. These projections for the year 2000 range from 350 ppm upwards to 415 ppm, with a likely value close to 385 ppm (Machta, 1972). That is about an 18% increase over present values, and more than 30% over the base-line value from the 1800's.

While such concentrations are small in an absolute sense and not a direct threat to man, the range of indirect consequences seems large. Such impacts can be expected to involve both the climate and the biosphere. Although a trace gas, carbon dioxide plays a vital role in the atmospheric radiation balance. Studies in the last twenty years have sought to refine numerical calculations of the potential effects and current estimates, which attempt to account for at least some other atmospheric mechanisms (e.g., convective adjustment), indicate that a doubling of carbon dioxide (from 300 ppm to 600 ppm) would increase global average surface temperature by 2 to 3 K (see for example Manabe and Wetherald, 1967 and a draft review Schneider, 1975). There have been, so far, only a limited number of studies of the climatic effect in multi-dimensional models (e.g., Manabe and Wetherald, 1975) and these tend to indicate the effect will be at least as large as indicated by radiation models alone. What has not been done is to interpret the effects of these changes on man in terms of agriculture, life-style, ocean level, polar melting, etc. It should be noted, however, that the observed climate has responded somewhat differently than increased CO_2 alone would predict, and may do so in the future. This may be due to natural fluctuations or other factors, but in any case we will someday have to face up to the effects of increased CO_2, and should therefore be aware of them in advance whether they be beneficial or detrimental.

The second effect is biological. Much of the biological cycle has been treated in the AEC Symposium Series publication Carbon and Biosphere (Woodwell and Pecan, 1975). I sense that there remains a need for assessment of the CO_2 effects cascade and a comparison of the effects cascades between various energy systems. Of crucial importance in current discussions seems to be oceanic chemistry and its effect on marine organisms.

I write this letter to urge that carbon dioxide effects be considered in evaluating energy strategy for the next generation. Research seems needed in climatic effects as well as those biological areas suggested in the 1972 Carbon Symposium. Just as there is a program on the sulfur cycle, there should be one on the carbon cycle, trying to focus toward continuing evaluation of potential effects which can be used in long term energy planning.

Sincerely yours,

MCM:clm

c: J. B. Knox
D. H. Slade

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References:

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Addressees on Attached List

CARBON DIOXIDE ISSUE

You may not know that the legislation establishing ERDA has charged us with (1) reviewing ongoing research relating to energy, and (2) annual submission to Congress of a plan and program to achieve solutions to the energy supply and associated environmental problems.

Dr. MacCracken has summarized the carbon dioxide issue (enclosed) at my request so that I can use it as a stimulus in initiating an ERDA evaluation of CO_2 research.

Would you please let me know

(1) whether you believe that the National program on CO_2 is adequate in view of the time scale of the problem

(2) whether you can identify weaknesses which additional funding would help alleviate

(3) what mechanism you suggest for settling on an answer to the above two questions (for instance, should the annual AMS chemist-meteorologist workshop be used to address the questions?)

Your responses may be written or by phone (301-973-4374) if you prefer. Mr. David Slade will be in the thick of this, so you may call him (301-973-3763) should I be out.

Rudolf J. Engelmann
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bcc: C. W. Edington, w/encl.
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EP Rdg. File

Enclosure:
As stated

cc: M. MacCracken, w/o encl.
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